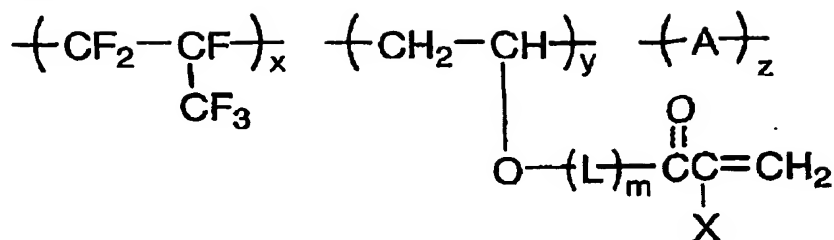CLAIMS

1.   An antireflection film comprising:

a transparent support; and

a low-refractive index layer having a lower refractive index than the transparent support, wherein the low-refractive index layer is an outermost layer of the antireflection film, and the low-refractive index layer comprises: a hollow silica particle; and a compound lowering a surface free energy of the antireflection film.

2.   The antireflection film as claimed in claim 1, wherein the compound is at least one selected from the group consisting of a silicone compound, a fluorine-containing compound and a fluoroalkylsilicone compound.

3.   The antireflection film as claimed in claim 2, wherein the compound is the silicone compound.

4.   The antireflection film as claimed in any of claims 1 to 3, wherein the low-refractive index layer comprises a binder, and the compound comprises a reactive group with the binder.

5.   The antireflection film as claimed in any of claims 1 to 4, wherein the compound comprises a (meth)acryloyl group.

6.   An antireflection film comprising:

a transparent support; and

a low-refractive index layer having a lower refractive index than the transparent support, wherein the low-refractive index layer is an outermost layer of the antireflection film, and the low-refractive index layer comprises: a hollow silica particle; and a binder capable of lowering a surface free energy of the antireflection film.

7.   The antireflection film as claimed in claim 6, wherein the binder comprises at least one of a silicone and a fluorine.

8.   The antireflection film as claimed in claim 6 or 7, wherein the binder is a fluorine-containing polymer.

9.   The antireflection film as claimed in any of claims 6 to 8, wherein the binder is a compound having a (meth)acryloyl group.

10.   The antireflection film as claimed in any of claims 6 to 9, wherein the binder is a compound represented by formula (1):

$$\left(CF_2 - \underset{\underset{CF_3}{|}}{CF} \right)_x \quad \left(CH_2 - \underset{\underset{\underset{X}{|}}{O - (L)_{\overline{m}} \overset{\overset{O}{||}}{C}C=CH_2}}{CH} \right)_y \quad \left(A \right)_z$$

wherein L represents a linking group having from 1 to 10 carbon atoms; X represents a hydrogen atom or a methyl group; A represents a repetitive unit derived from a vinyl monomer; x, y and z each indicates mol% of the respective repetitive unit, and satisfy $30 \leq x \leq 60$, $5 \leq y \leq 70$ and $0 \leq z \leq 65$.

11.   The antireflection film as claimed in any of claims 1 to 10, wherein at least one of a silicone and a fluoroalkyl group is segregated at an outer surface of the low-refractive index layer such that a spectral intensity ratio Si/C or F/C in a photoelectron spectrum at the outer surface is larger by at least 5 times than that at a depth from the outer surface, the depth being equal to 80 % of a thickness of the low-refractive index layer.

12.   The antireflection film as claimed in any of claims 1 to 11, wherein the surface free energy is at most 25 mN/m.

13.   The antireflection film as claimed in any of claims 1 to 12, which comprises a layer comprising at least one of a hydrolysate of an organosilane and a partial condensate of the organosilane, wherein the hydrolysate and the partial condensate is produced in the presence of at least one of an acid catalyst and a metal chelate compound, and the organosilane is represented by formula (A):

$$(R^{10})_m Si(X)_{4-m}$$

wherein R^{10} represents a substituted or unsubstituted alkyl group, or a substituted or unsubstituted aryl group; X represents a hydroxyl group or a hydrolyzable group; and m indicates an integer of 1 to 3.

14.   An antireflection film comprising:

a transparent support; and

a low-refractive index layer having a lower refractive index than the transparent support,

wherein

the low-refractive index layer has a refractive index of 1.30 to 1.55,

the low-refractive index layer is formed by applying a curable composition onto the transparent support; drying the curable composition; and curing the curable composition upon at least one of an ionizing irradiation and a heat application in an atmosphere having an oxygen concentration of at most 15 % by volume, and

the curable composition comprises: (A) a curable substance comprising acrosslinking or polymerizing functional group; (B) a hallow inorganic particle having a mean particle size of 30 % to 150 % of a thickness of the low-refractive index layer, the hollow inorganic particle having a refractive index of 1.17 to 1.40; (C) at least one of a first polymerization initiator capable of generating a radical upon the ionizing irradiation and a second polymerization initiator capable of generating a radical upon the heat application; and (D) a solvent capable of

dissolving or dispersing components (A) to (C).

15.   The antireflection film as claimed in claim 14, wherein the low-refractive index layer further comprises at least one selected from the group consisting of a silicone compound, a fluorine-containing compound and a fluoroalkylsilicone compound.

16.   The antireflection film as claimed in claim 14 or 15, wherein the curable substance is a polyfunctional (meth)acrylate monomer.

17.   The antireflection film as claimed in any of claims 14 to 16, wherein the curable composition principally has the curable substance, the curable substance being a fluorine-containing polymer,

wherein the fluorine-containing polymer comprises: a fluorine atom of 35 to 85 % by weight; and acrosslinking or polymerizing functional group, and

the fluorine-containig polymer is a copolymer, wherein the copolymer comprises: a first polymerizable unit of a vinyl monomer comprising a fluorine; and a second polymerization unit having a side branch, the side branch comprising a functional group of one of a (meth)acryloyl group and a glycidyl group, and the copolymer has a backbone chain consisting of a carbon atom.

18.   The antireflection film as claimed in any of claims 14 to 17, wherein the curable composition further comprises at least one of an organosilane compound, a hydrolysate of the organosilane compound and a partial condensate of the organosilane compound, the organosilane compound being represented by formula (A1):

$$(R^{101})_m Si(X)_{4-m}$$

wherein R^{101} represents an alkyl group; X represents a hydroxyl group or a hydrolyzable group; and m indicates an integer of 1 to 3.

19.   An antireflection film comprising:

a support comprising a cellulose acylate film, the cellulose acylate film having a thickness of 30 to 120 μm;

an antireflection layer comprising: at least one of a light-diffusing layer and a high-refractive index layer, the high-reflactive index layer having a higher refractive index than the support; and a low-refractive index layer having a lower refractive index than the support in this order,

wherein

the cellulose acylate film is a long film having a length of 100 to 5,000 m and a width of at least 0.7 m; the cellulose acylate film has a thickness fluctuation range of –3 to 3 %; and the cellulose acylate film has a curl of –7 to +7 /m in a width direction of the cellulose acylate film, and

the low-refractive index layer comprises a hollow silica particle having a refractive index of 1.17 to 1.40.

20.   The antireflection film as claimed in claim 19, wherein the cellulose acylate film satisfies formulae (I) and (II):

(I) $2.3 \leq SA' + SB' \leq 3.0,$

(II) $0 \leq SA' \leq 3.0$

wherein SA' means a degree of substitution with an acetyl group, the acetyl group substituting for a hydrogen atom of a hydroxyl group in a cellulose; and SB' means a degree of substitution with an acyl group having from 3 to 22 carbon atoms, the acyl group substituting for the hydrogen atom of the hydroxyl group in the cellulose.

21.   The antireflection film as claimed in claim 19 or 20, wherein the cellulose acylate film comprising, as a plasticizer, a polyalcohol ester of an aliphatic polyalcohol and a monocarboxylic acid, and

the cellulose acylate film has a moisture permeability of 20 to 260 g/m^2 under a condition of 25°C and 90 % RH for 24 hours.

22.   The antireflection film as claimed in claim 21, wherein the monocarboxylic acid of the polyalcohol ester comprises at least one of an aromatic ring and an alicyclic ring.

23.   The antireflection film as claimed in any of claims 19 to 22, wherein the cellulose acyalte film has an exudation degree of 0 to 2.0 %.

24.   .   The antireflection film as claimed in any of claims 19 to 23, wherein the cellulose acylate film comprises a UV-absorbing copolymer of a UV-absorbing monomer having a a molar extinction coefficient of at least 4,000 at 380 nm and an ethylenic unsaturated monomer, and the UV-absorbing copolymer has a weight-average molecular weight of 2,000 to 20,000.

25.   The antireflection film as claimed in any of claims 19 to 24, wherein the cellulose acylate film has a surface having a surface irregularity based on JIS B0601-1994 such that: an arithmetical mean roughness (Ra) is from 0.0005 to 0.1 μm; a ten-point mean roughness (Rz) is from 0.001 to 0.3 μm; and a mean distance of the surface irregularity (Sm) is at most 2 μm, and

the number of optical defects each having a visual size of at least 100 μm in the surface is at most 1/m^2.

26.   The antireflection film as claimed in any of claims 19 to 25, wherein each in-plane change of L*, a* and b* values in a color space CIE1976L*a*b* of a reflected light from the antireflection film is at most 20 %,

wherein the reflected light is a regular-reflected light to an incident light having an incident angle of 5 degree, the incident light has a wavelength of 380 nm to 780 nm, and the incident light is a light from a CIE standard light source D65.

27.   The antireflection film as claimed in any of claims 19 to 26, wherein a change of a mean reflectivity in a wavelength range of 380 nm to 680 nm is at most 0.4 % before and after a weather resistance test, and

a color tone change ΔE of a reflected light is at most 15 on an L*a*b chromaticity diagram.

28.   The antireflection film as claimed in any of claims 19 to 27, wherein the low-refractive

269

index layer further comprises a composition comprising at least one of a hydrolysate of an organosilane and a partial condensate of the organosilane, and the organosilane is represented by formula (A2):

$$R_mSi(X)_n$$
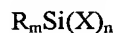
wherein X represents -OH, a halogen atom, $-OR^{102}$ or $-OCOR^{102}$; R and R^{102} each represents a substituted or unsubstituted alkyl group having from 1 to 10 carbon atoms; m + n = 4, and m and n each indicate an integer of 0 or more.

29.   A method for producing an antireflection film, which comprises:

applying a curable composition onto a transparent support;

drying the curable composition; and

curing the curable composition upon at least one of an ionizing irradiation and a heat application in an atmosphere having an oxygen concentration of not higher than 15 % by volume, so as to form a low-refractive index layer having a refractive index of 1.30 to 1.55 on the transparent support,

wherein

the curable composition comprises: (A) a curable substance comprising acrosslinking or polymerizing functional group; (B) an hollow inorganic particle having a mean particle size of 30 % to 150 % of a thickness of the low-refractive index layer, the hallow inorganic particle having a refractive index of 1.17 to 1.40; (C) at least one of a first polymerization initiator capable of generating a radical upon the ionizing irradiation and a second polymerization initiator capable of generating a radical upon the heat application; and (D) a solvent capable of dissolving or dispersing components (A) to (C).

30.   A polarizing plate comprising an antireflection film of any of claims 1 to 28.

31.   A polarizing plate comprising:

a polarizing sheet; and

a transparent protective film on one side of the polarizing sheet, the transparent protective film comprising an antireflection film of any of claims 1 to 28.

32.   A polarizing plate comprising:

a polarizing sheet; and

a transparent protective film on each side of the polarizing sheet,

wherein

the transparent protective film on one side of the polarizing sheet has a multi-layered antireflective film,

the multi-layered antireflective film comprises a high-refractive index layer having a higher refractive index than the transparent protective film; and a low-refractive index layer having a lower refractive index than the transparent protective film,

the high-refractive index layer and the low-refractive index layer are formed by applying each coating solution thereof in this order,

the low-refractive index layer comprises an hollow inorganic particle, the hollow inorganic particle having a refractive index of 1.17 to 1.37 and a mean particle size of 30 % to 100 % of a thickness of the low-refractive index layer.

33.   The polarizing plate as claimed in claim 32, which has a first transmittance at 700 nm of 0.001 % to 0.3 % under a cross nicol condition and a second transmittance at 410 nm of 0.001 % to 0.3 % under the cross nicol condition.

34.   The polarizing plate as claimed in claim 32 or 33, wherein each in-plane change of L*, a* and b* values in a color space CIE1976L*a*b* of a reflected light from the polarizing plate is at most 20 %,

wherein the reflected light is a regular-reflected light to an incident light having an incident angle of 5 degree, the incident light has a wavelength of 380 nm to 780 nm, and the incident light is a light from a CIE standard light source D65.

35.   The polarizing plate as claimed in any of claims 32 to 34, wherein a light transmittance change and polarization change of the polarizing plate before and after allowed to stand in an atmosphere at 60°C and 90 % RH for 500 hours each is at most 3 % in terms of absolute value.

36.   The polarizing plate as claimed in any of claims 32 to 35, wherein a dimensional change in each direction of an absorption axis and polarization axis of the polarizing plate before and after allowed to stand under a heat condition of 70°C for 120 hours is within ± 0.6 %.

37.   The polarizing plate as claimed in any of claims 32 to 36, wherein an angle between stretch axes of the transparent protective film and the polarizing sheet is from 10° to less than 90°.

38.   The polarizing plate as claimed in any of claims 31 to 37, wherein the transparent protective film on the other side of the polarizing sheet has an optical compensation film comprising an optical anisotropic layer.

39.   The polarizing plate as claimed in claim 38, which has the polarizing sheet; the transparent protective film on the other side of the polarizing sheet; and the optical compensation film in this order,

wherein

the optical anisotropic layer comprising a compound has a discotic structure,

a disc face of the discotic structure is inclined relative to a film surface of the transparent protective film, and

an angle between the disc face and the film surface varies in a depth direction of the optical anisotropic layer.

40.   A method for producing a polarizing plate of any of claims 30 to 39, which comprises:

feeding a polymer film for a polarizing sheet;

holding each edge of the polymer film with a holding unit; and

stretching the polymer film by imparting a tension to the polymer film while moving the holding unit in a machine direction of the polymer film

wherein

the stretching is performed under a condition satisfying formula (III):

$$|L2 - L1| > 0.4W$$

wherein L1 indicates a locus of the first holding unit from a substantial holding start point to a substantial holding release point on one edge of the polymer film; L2 indicates a locus of the second holding unit from a substantial holding start point to a substantial holding release point on the other edge of the polymer film; and W indicates a distance between two substantial holding release points of the first holding unit and the second holding unit, and

a speed difference of the moving between the first holding unit and the second holding unit is less than 1 %.

41.   The method for producing a polarizing plate as claimed in claim 40, wherin the stretching is performed under keeping a volatile content of the polymer film at least 5 % by volume, and the volatile content is decreased while the polymer film is shrunk.

42.   The method for producing a polarizing plate as claimed in claim 40 or 41, which comprises sticking a transparent protective film to one side of the polarizing sheet, the protective film having aantireflection film.

43.   An image display device comprising an antireflection film of any of claims 1 to 28 or a polarizing plate of any of claims 30 to 39.

44.   The image display device as claimed in claim 43, which is a liquid crystal display device.

45.   The image display device as claimed in claim 43, which is a transmissive, reflective or semi-transmissive liquid crystal display of any mode of TN, STN, IPS, VA or OCB

46.   A liquid crystal display element comprising:

an upper polarizing plate;

a liquid crystal cell comprising two cell substrates; and

a lower polarizing plate in this order, wherein the upper polarizing plate and the lower polarizing plate each comprises: an upper transparent protective film; a polarizing sheet; and a lower transparent protective film in this order, and the lower polarizing plate comprises a brightness-improving film,

wherein

the upper transparent protective film comprises: a transparent support; and an antireflection film, the antireflection film comprising a low-refractive index layer having a lower refractive index than the transparent support, wherein the low-refractive index layer is an outermost layer of the transparent support, and the low-refractive index layer comprises a hollow inorganic particle, the hollow particle having a refractive index of 1.17 to 1.37 and a mean particle size of 30 % to 100 % of a thickness of the low-refractive index layer.

47.   The liquid crystal display element as claimed in claim 46, wherein the low-refractive index layer is a cured film formed by applying and curing a curable composition,

wherein the curable composition comprises: the hollow inorganic particle; s fluorine-containing polymer comprising a curable reactive group; and at least one of a hydrolysate of an organosilane and a partial

condensate of the organosilane, wherein the hydrolysate and the partial condensate is produced in the presence of at least one of an acid catalyst and a metal chelate compound, and the organosilane is represented by formula (A):

$$(R^{10})_m Si(X)_{4-m}$$

wherein R^{10} represents a substituted or unsubstituted alkyl group, or a substituted or unsubstituted aryl group; X represents a hydroxyl group or a hydrolyzable group; and m indicates an integer of 1 to 3.

48.   The liquid crystal display element as claimed in claim 46 or 47, wherein the antireflection film comprises a high-refractive index layer having a higher refractive index than the transparent support between the low-refractive index layer and the transparent support.

49.   The liquid crystal display element as claimed in claim 46 or 47, wherein the antireflection film has an antiglare layer having a higher refractive index than the transparent support between the low-refractive index layer and the transparent support.

50.   The liquid crystal display element as claimed in any of claims 46 to 49, wherein the upper polarizing plate comprises: the antireflection film; the transparent support; the polarizing sheet; and another transparent support in this order from the outermost side of the upper polarizing plate, which are stucked and integrated to form the upper polarizing plate.

51.   The liquid crystal display element as claimed in any of claims 46 to 50, wherein the upper polarizing plate further comprises an opticalcompensation film on a side adjacent to the liquid crystal cell.

52.   The liquid crystal display element as claimed in any of claims 46 to 51, wherein the lower polarizing plate comprises: an optical compensation film; the polarizing sheet, the transparent protective film and the brightness-improving film in this order from a side adjacent to the liquid crystal cell.

53.   The liquid crystal display element as claimed in any of claims 46 to 52, wherein the transparent support is a cellulose acylate film comprising a cellulose acylate satisfying formulae (I) and (II); a plasticizer having an octanol-water partition coefficient (log P) of 0 to 10; and a fine particle having a mean primary particle size of 3 to 100 nm, and the cellulose acylate film has a thickness of 20 to 120 μm:

(I)   . $2.3 \leq SA' + SB' \leq 3.0$

(II) $0 \leq SA' \leq 3.0$

wherein SA' means a degree of substitution with an acetyl group that substitutes for a hydrogen atom of a hydroxyl group in a cellulose; and SB' means a degree of substitution with an acyl group having from 3 to 22 carbon atoms, the acyl group substituting for the hydrogen atom of the hydroxyl group in the cellulose.

54.   The liquid crystal display element as claimed in any of claims 46 to 53, wherein each in-plane change of L*, a* and b* values in a color space CIE1976L*a*b* of a reflected light from the antireflection film is less than 15 %,

wherein the reflected light is a regular-reflected light to an incident light having an incident angle of 5 degree, the incident light has a wavelength of 380 nm to 780 nm, and the incident light is a light from a CIE standard light source D65.

55.   The liquid crystal display element as claimed in any of claims 46 to 53, wherein a change of a mean reflectivity of the antirefrection film in a wavelength range of 380 nm to 680 nm is at most 0.5 % before and after a weather resistance test, and

a color tone change ΔE of a reflected light form the antireflection film is at most 15 on an L*a*b chromaticity diagram.

56.   A liquid crystal display device comprising a liquid crystal display element of any of claims 46 to 55.

57.   The liquid crystal display device as claimed in claim 56, which further comprises a backlight.

58.   The liquid crystal display device as claimed in claim 56 or 57, which is a transmissive, reflective or semi-transmissive liquid crystal display of any mode of TN, STN, IPS, VA or OCB.